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In re: Williams *et al.*

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Examiner: James Lin

APPENDIX A

Concentration Gradient

concentration gradient

noun

1. a gradual change in the concentration of solutes in a solution as a function of distance through a solution.
2. the gradual difference in the concentration of solutes in a solution between two regions. In biology, a gradient results from an unequal distribution of ions across the cell membrane. When this happens, solutes move along a concentration gradient. This kind of movement is called *diffusion*.

**The movement of solutes along a concentration gradient is common in many biological processes. For a more elaborated discussion, read the Tutorial in Cell Biology where various ways substances pass through a cell membrane are described.*

Please contribute to this project, if you have more information about this term feel free to edit this page

Dictionary » G » Gradient

Gradient

Gradient

(Science: physics) mathematical term for the operator which determines the magnitude and direction of the greatest rate-of-change of a given function with position. Similarly used to describe such a rate-of-change.

For instance, at a given point on a hill, the slope of the hill in the steepest uphill direction is the gradient of the altitude function for the hill.

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gradient

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gradient

Main Entry: **gra·di·ent**
Pronunciation: \ˈgrā-dē-ənt\
Function: *noun*
Etymology: Latin *gradient-, gradiens,* present participle of *gradi*
Date: 1835

1 a : the rate of regular or graded ascent or descent : INCLINATION **b :** a part sloping upward or downward
2 : change in the value of a quantity (as temperature, pressure, or concentration) with change in a given variable and especially per unit distance in a specified direction
3 : the vector sum of the partial derivatives with respect to the three coordinate variables *x, y,* and *z* of a scalar quantity whose value varies from point to point
4 : a graded difference in physiological activity along an axis (as of the body or an embryonic field)
5 : change in response with distance from the stimulus

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gradient

<physics> Mathematical term for the operator which determines the magnitude and direction of the greatest rate-of-change of a given function with position. Similarly used to describe such a rate-of-change.

For instance, at a given point on a hill, the slope of the hill in the steepest uphill direction is the gradient of the altitude function for the hill.

(09 Oct 1997)

Previous: grade III astrocytoma, grade IV astrocytoma, Gradenigo, Giuseppe, Gradenigo's syndrome
Next: gradient elution, gradient encoding, gradient perception, grading

Dictionary:

concentration gradient

n.

The graduated difference in concentration of a solute per unit distance through a solution.

Wikipedia: electrochemical gradient

In cellular biology, an electrochemical gradient refers to the electrical and chemical properties across a membrane. These are often due to *ion gradients*, particularly *proton gradients*, and can represent a type of potential energy available for work in a cell. This can be calculated as a thermodynamic measure termed electrochemical potential that combines the concepts of energy stored in the form of chemical potential which accounts for an ion's *concentration gradient* across a cellular membrane and electrostatics which accounts for an ion's tendency to move relative to the membrane potential.

Overview

Electrochemical potential is important in electroanalytical chemistry and industrial applications such as batteries and fuel cells. It represents one of the many interchangeable forms of potential energy through which energy may be conserved.

In biological processes the direction an ion will move by diffusion or active transport across membrane is determined by the electrochemical gradient. In mitochondria and chloroplasts, proton gradients are used to generate a chemiosmotic potential that is also known as a proton motive force. This potential energy is used for the synthesis of ATP by oxidative phosphorylation.

An electrochemical gradient has two components. First, the electrical component is caused by a charge difference across the lipid membrane. Second, a chemical component is caused by a differential concentration of ions across the membrane. The combination of these two factors determines the thermodynamically favourable direction for an ion's movement across a membrane.

Electrochemical gradients are analogous to hydroelectric dams and equivalent to the water pressure across the dam. Membrane transport proteins such as the sodium-potassium pump within the membrane are equivalent to turbines that convert the waters potential energy to other forms of physical or chemical energy, and the ions that pass through the membrane are equivalent to water that is now found at the bottom of the dam. Alternatively, energy can be used to pump water up into the lake above the dam. Similarly chemical energy in cells can be used to create electrochemical gradients.

Chemistry

The term is typically applied in contexts where a chemical reaction is to take place, such as one involving the transfer of an electron at a battery electrode. In a battery, an electrochemical potential arising from the movement of ions balances the reaction energy of the electrodes. The maximum voltage that a battery reaction can produce is sometimes called the standard electrochemical potential of that reaction (see also electrode potential and Table of standard electrode potentials). In instances pertaining specifically to the movement of electrically charged solutes, the potential is often expressed in units of volts. See: Concentration cell

Biological context

In biology, the term is sometimes used in the context of a chemical reaction, in particular to describe the energy source for the chemical synthesis of ATP. More generally, however, it is used to characterize the inclined tendency of solutes to simply diffuse across a membrane, a process involving no chemical transformation.

Ion gradients

With respect to a cell, organelle, or other subcellular compartments, the inclined tendency of an electrically charged solute, such as a potassium ion, to move across the membrane is decided by the difference in its electrochemical potential on either side of the membrane, which arises from three factors:

- the difference in the concentration of the solute between the two sides of the membrane
- the charge or "valence" of the solute molecule
- the difference in voltage between the two sides of the membrane (i.e. the transmembrane potential).

A solute's electrochemical potential difference is zero at its "reversal potential". The transmembrane voltage to which the solute's net flow across the membrane is also zero. This potential is predicted theoretically either by the Nernst equation (for systems of one permeant ion species) or the Goldman-Hodgkin-Katz equation (for more than one permeant ion species). Electrochemical potential is measured in the laboratory and field using reference electrodes.

Transmembrane ATPases or transmembrane proteins with ATPase domains are often used for making and utilizing ion gradients. The enzyme Na^+/K^+ ATPase use ATP to make a sodium ion gradient and a potassium ion gradient. The electrochemical potential is used as energy storage, chemiosmotic coupling is one of several ways a thermodynamically unfavorable reaction can be driven by a thermodynamically favorable one. Cotransport of ions by symporters and antiporter carriers are common to actively move ions across biological membranes.

Proton gradients

The proton gradient can be used as an intermediate energy storage for heat production and flagellar rotation. Additionally, it is an interconvertible form of energy in active transport, electron potential generation, NADPH synthesis, and ATP synthesis/hydrolysis.

The electrochemical potential difference between the two sides of the membrane in mitochondria, chloroplasts, bacteria and other membranous compartments that engage in active transport involving proton pumps, is at times called a chemiosmotic potential or proton motive force (see chemiosmosis). In this context, protons are often considered separately using units either of concentration or pH.

Proton Motive Force: two protons are expelled at each coupling site, generating the Proton Motive Force. ATP is made indirectly using the PMF as a source of energy. Each pair of protons yields one ATP.

Some archaea, most notably halobacteria, make proton gradients by pumping in protons from the environment with the help of the solar driven enzyme bacteriorhodopsin, here it is used for driving the molecular motor enzyme ATP synthase to make the necessary conformational changes required to synthesize ATP.

Proton gradients are also made by bacteria by running ATP synthase in reverse; this is used to drive flagella.

The F_1F_O ATP synthase is a reversible enzyme. Large enough quantities of ATP cause it to create a transmembrane proton gradient. This is used by fermenting bacteria - which do not have an electron transport chain, and hydrolyze ATP to make a proton gradient - which they use for flagella and the transportation of nutrients into the cell.

In respiring bacteria under physiological conditions, ATP synthase generally runs in the opposite direction creating ATP while using the proton motive force created by the electron transport chain as a source of energy. The overall process of creating energy in this fashion is termed: oxidative phosphorylation. The same process takes place in mitochondria where ATP synthase is located in the inner mitochondrial membrane, so that F_1-part sticks into mitochondrial matrix, where ATP synthesis takes place.

References

- Campbell, Reece (2005). *Biology*. Pearson Benjamin Cummings. ISBN 0-8053-7146-X.
- [1]

External links

See also

- Concentration cell
- Transmembrane potential difference
- Action potential
- Cell potential
- Electrodiffusion
- Galvanic cell
- Electrochemical cell